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Methods for restoring and describing ancient clinoform geometries – exemplified by the Middle Triassic Kobbe Formation, Norwegian Barents Sea

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Clinoform geometries are widely used to interpret paleobathymetry since they mark a relative change from shallow to deeper waters. Individual clinoform surfaces can be classified and distinguished based on distinct parameters defined by discrete breaks in the clinoform slope. The breaks in the clinoform slope are most often readily interpreted manually, but these interpretations are subjective and the placement of clinoform breaks have for this reason remained not strictly uniform. When analyzing mud-dominated systems where clinoform geometries typically display gentle transitions and less accentuated breaks in slope, distinct breaks in slope can vary over many kilometers depending on its selection criteria and detection method. The older and more complex post-depositional history the investigated strata has experienced, the harder it becomes to correctly place the different breaks in slope.

We propose a common reference frame for objectively and accurately describing and measuring parameters such as relief, length, and gradient, in addition to numerically defining the bottomset, foreset and topset segments of the clinoform surface. Different clinoform shapes within this reference frame are reconstructed using decompaction and backstripping with respect to Airy and flexural isostasy. Restored clinoform shapes are examined using regression analysis, which enables comparison with modern counterparts unaltered by post-depositional subsidence and compaction. The proposed procedure can be applied to 2D profiles from seismic, outcrop or closely spaced well logs, but also help in the analyses of 3D surfaces and the trajectory of discrete breaks in slope.

The proposed method is presented for a Middle Triassic clinoform package with documented deltaic topsets and heterolithic prodelta areas prograding many hundreds of kilometers in a relatively shallow (c. 100-300 m deep) basin the Barents Sea. Channelized sandstone deposits and clinoform topsets, partially based on previous interpretations of clinoform geometries, have been targets for hydrocarbon exploration with disappointing results. Better methods for analyzing clinoform geometries could ideally help towards future exploration efforts.